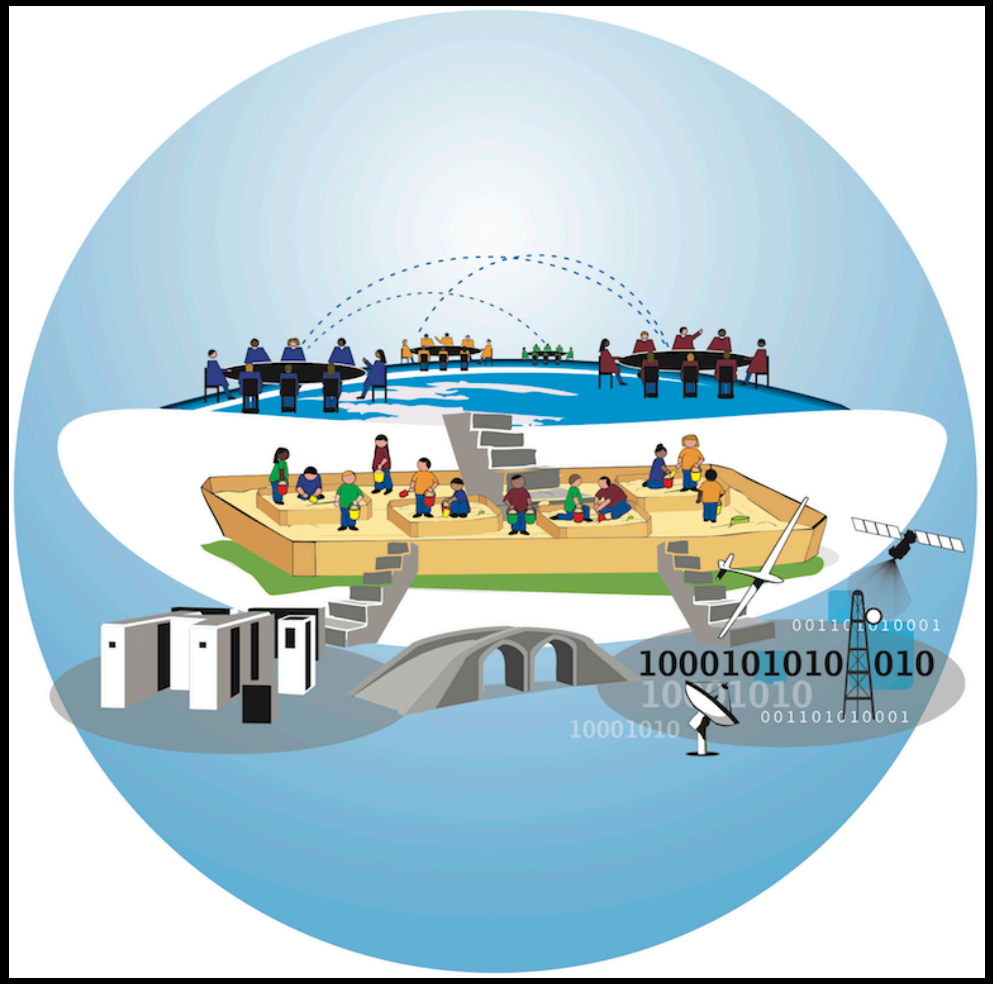
NASA EARTH EXCHANGE
IN SUPPORT OF THE
NATIONAL CLIMATE ASSESSMENT

NASA Advanced Supercomputing/Earth Science Division
NASA Ames Research Center
Moffett Field, CA
Rama Nemani, rama.nemani@nasa.gov
Weile Wang, weile.wang@gmail.com

November 20, 2012

NASA EARTH EXCHANGE



NEX is a virtual collaborative that brings scientists together in a knowledge-based social network and provides the necessary tools, computing power, and data to accelerate research and innovation.

Pleiades

NASA's fastest supercomputer

COLLABORATION
(over 340 members)

COMPUTING
(9PB, 180,000 cores)

Centralized Data Repository
(over 400 TB of data)

NCA@NEX Objectives

- **Develop high resolution climate projections data.**

  Empower the community for creating a high resolution downscaled climate projections data set useful for climate impact assessments.

- **Develop climate change indicators and monitor**ing:

  Analysis of long-term satellite data for the U.S. to quantify spatial and temporal patterns in indicators of terrestrial ecosystem condition.

- **Facilitate climate impacts modeling**:

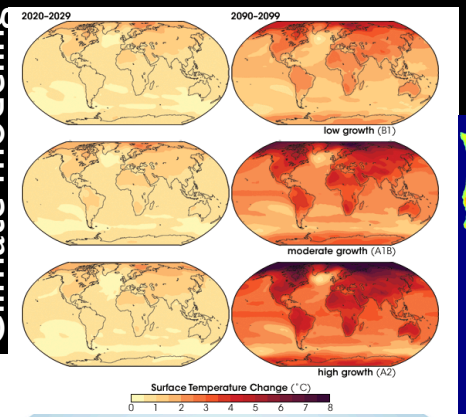
  Facilitate ensemble modeling experiments to quantify changes in biogeochemical cycling in response to changes in climate as well as land use.

NEX Enabling the National Climate Assessment

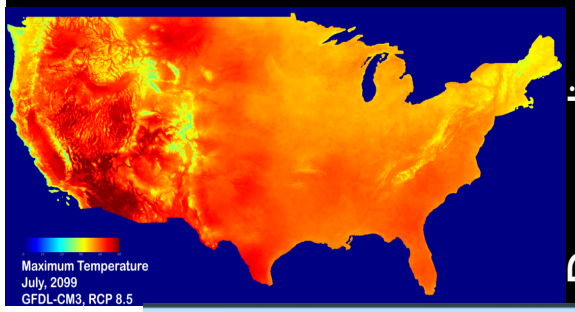
Promoting consistency, repeatability, and transparency in global change science

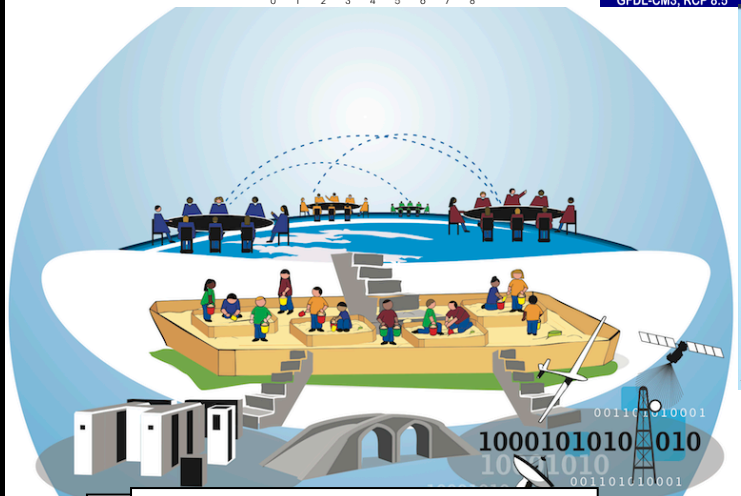
Every 4 years

Climate modeling

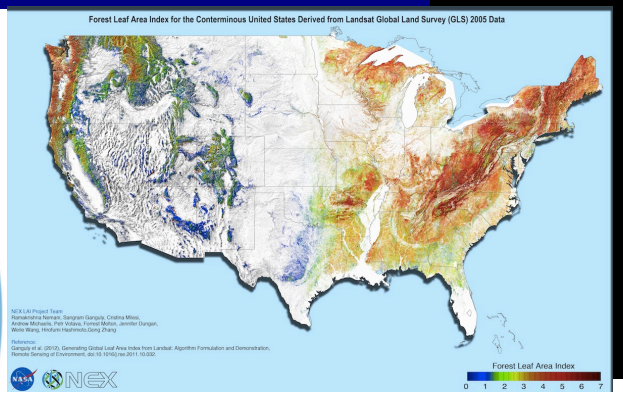


Downscaling

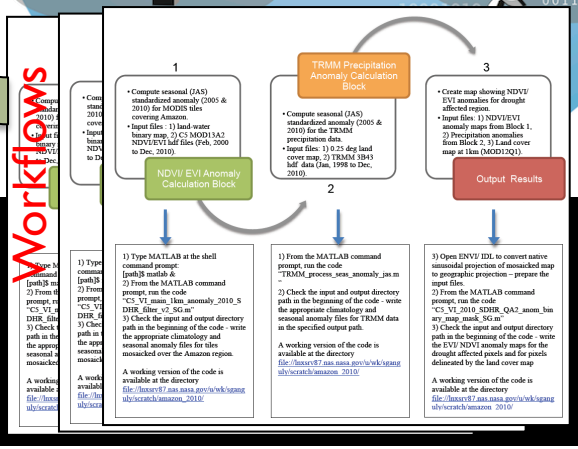




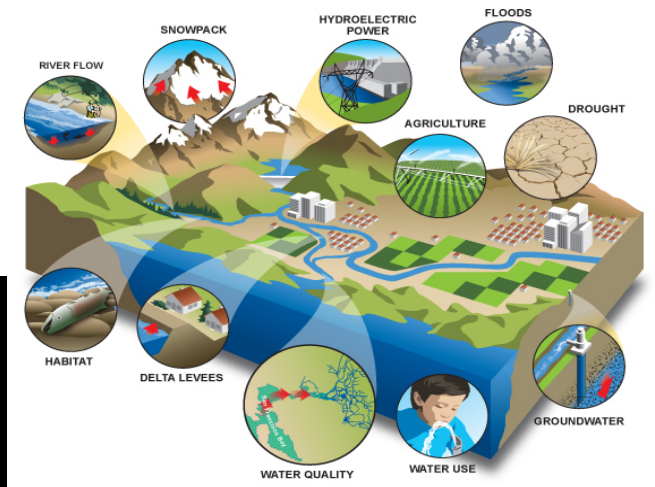
Long-term Satellite data analysis



Workflows

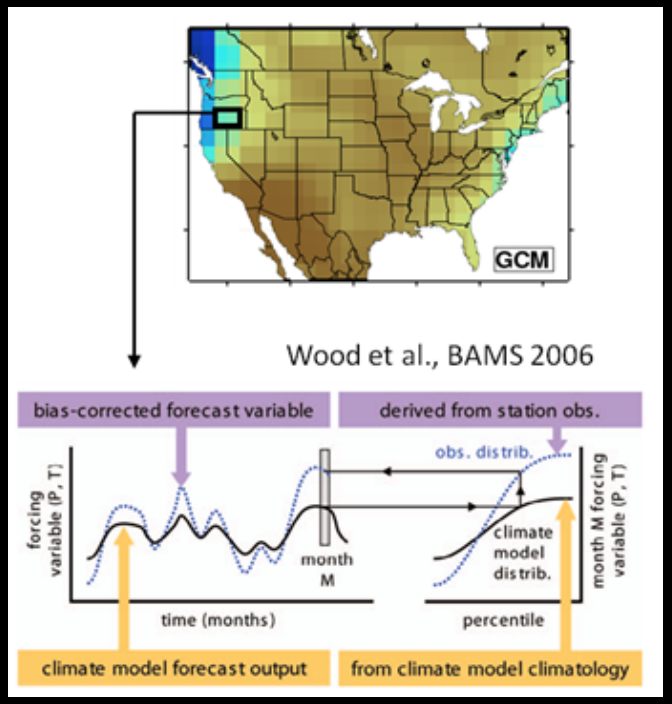


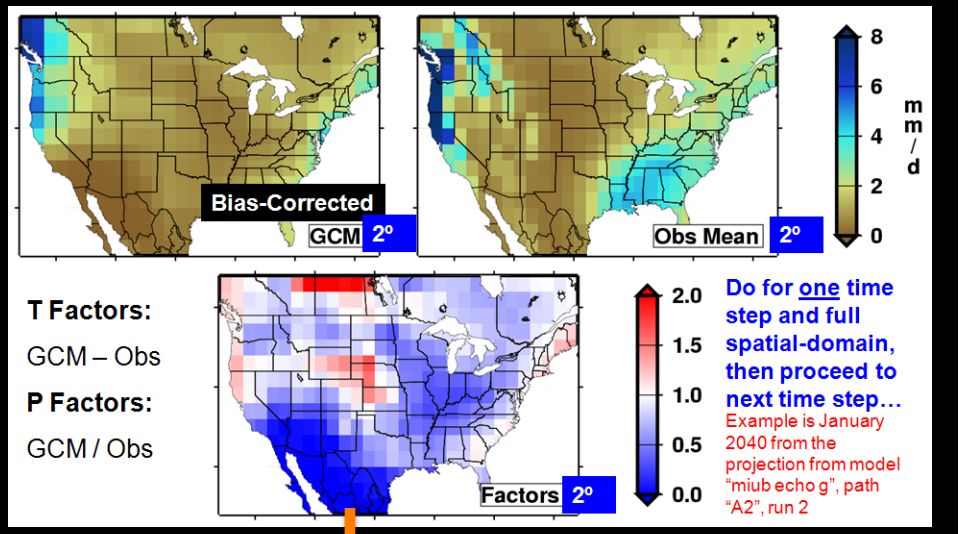
Modeling impacts

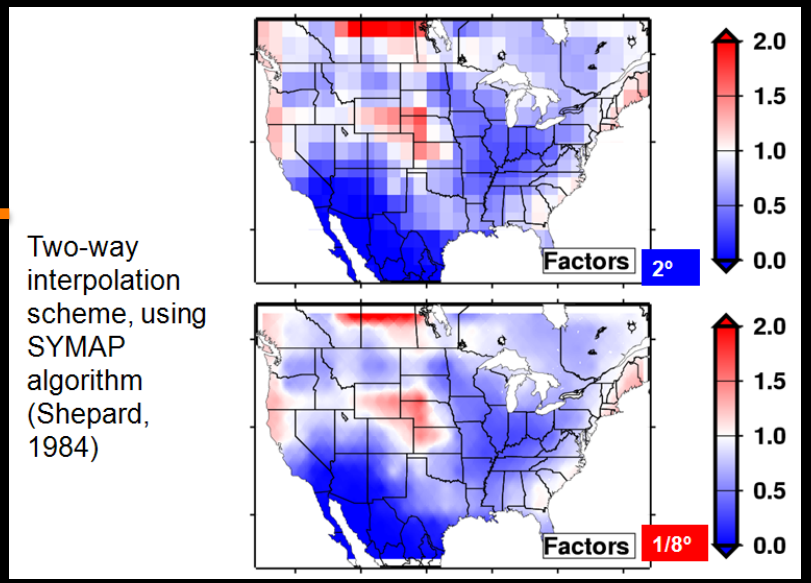


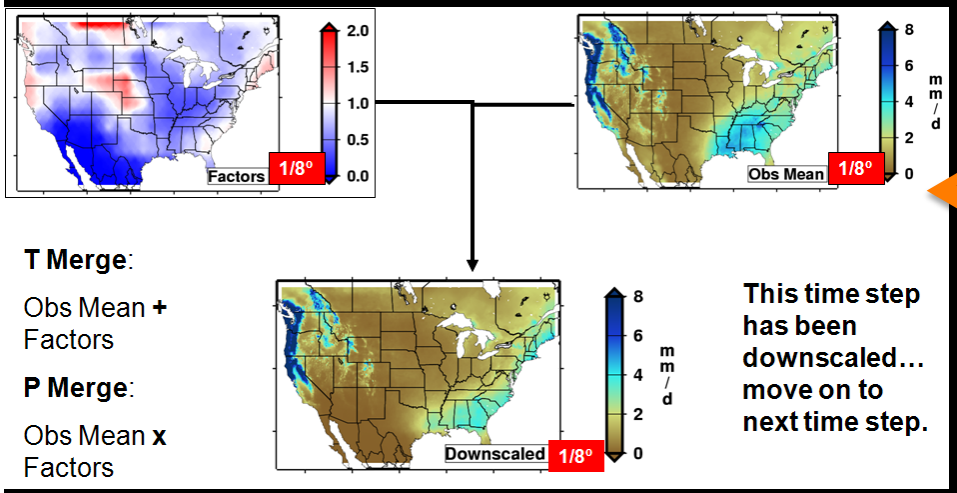
Activity 1: Creating high resolution (downscaled) climate projections

Bias-Correction Spatial Downscaling

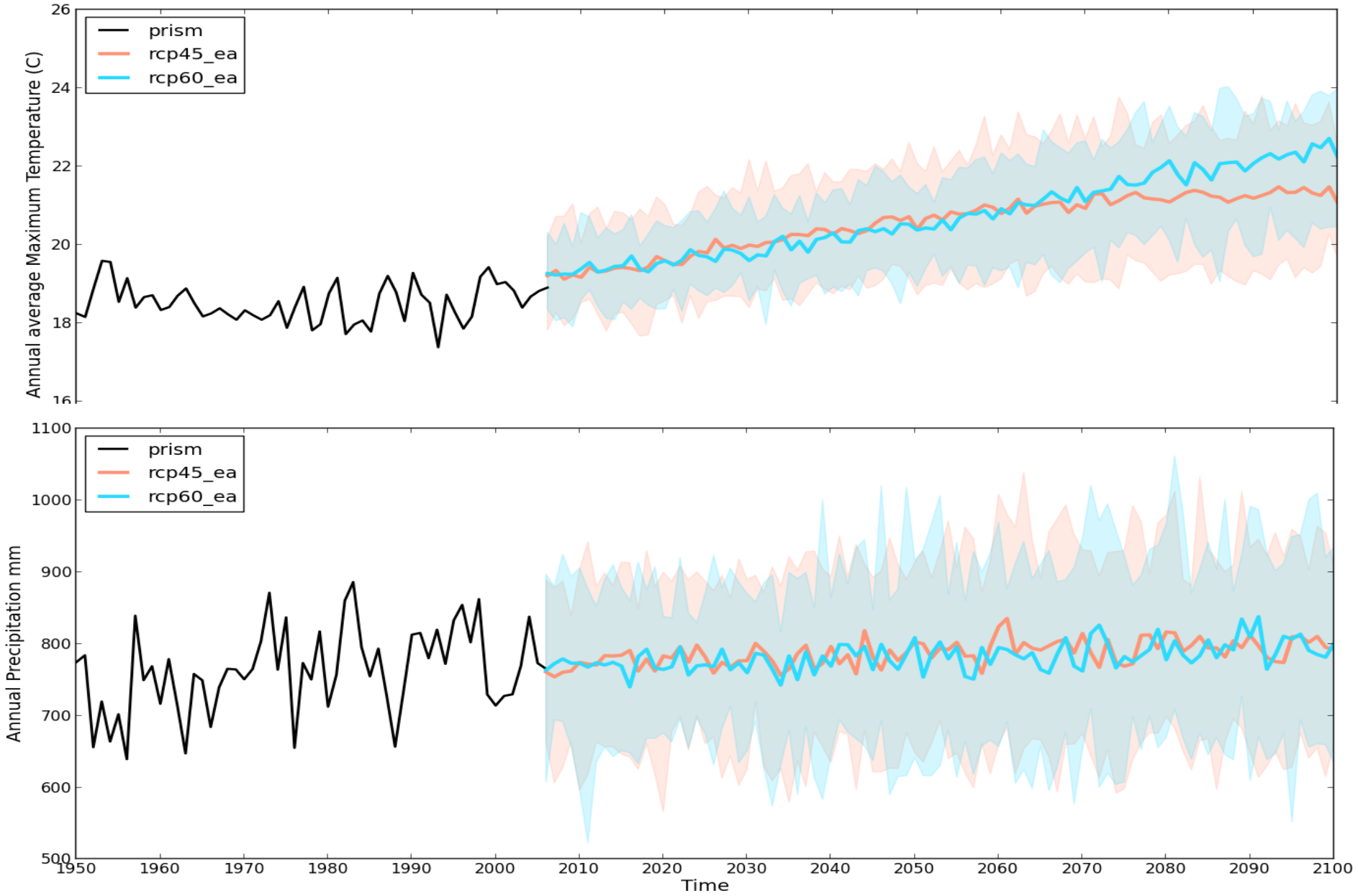








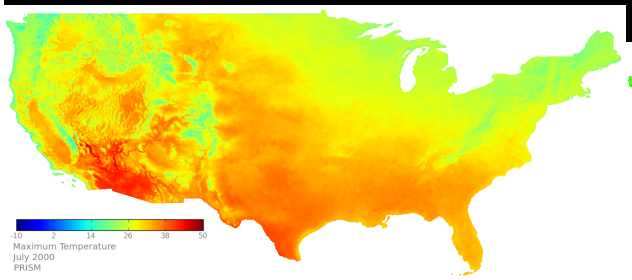
Not necessarily NASA's strength, but highly desired by the community



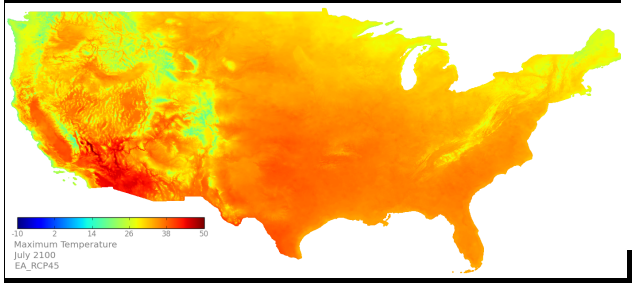
Ensemble mean and spread of the downscaled CMIP5 climate variables for conterminous US: (Top) annual maximum temperature; (Bottom) annual total precipitation

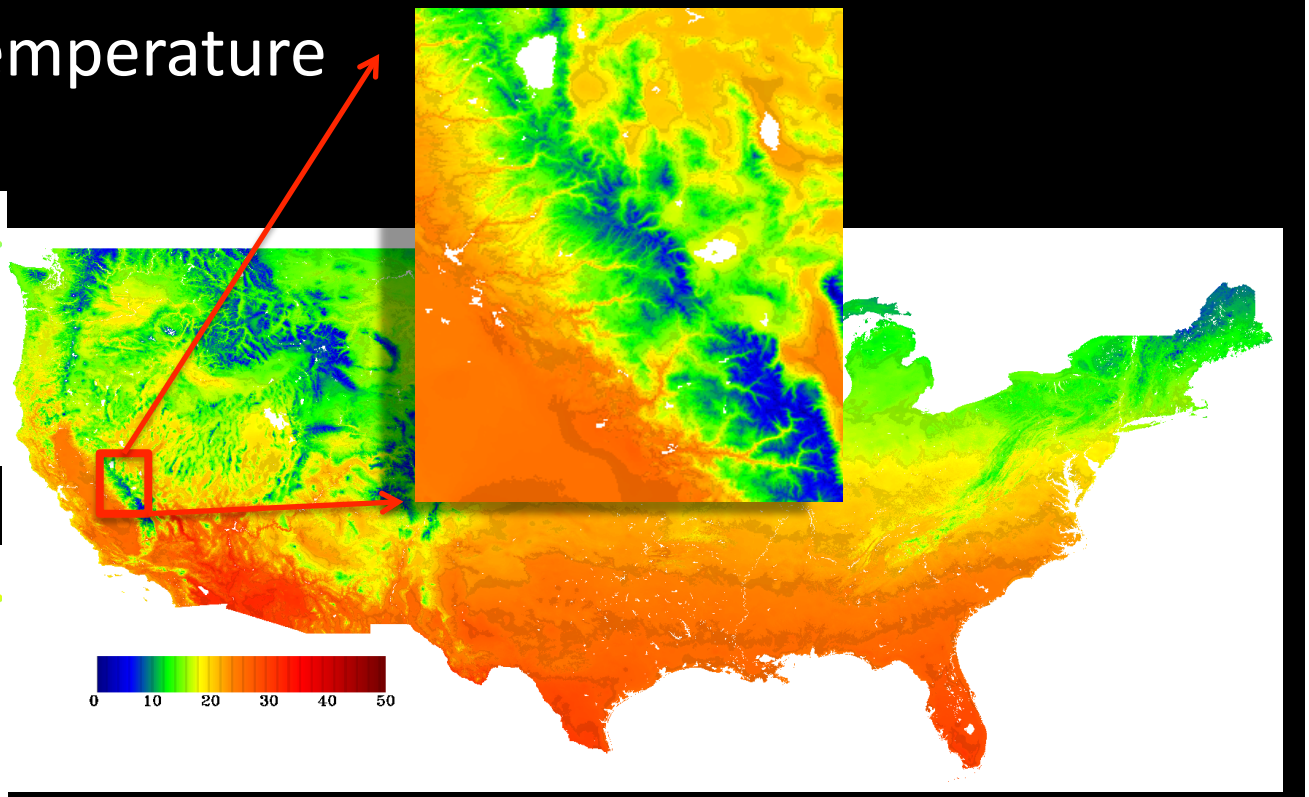
July Max Temperature

2000



2100





Input: 35 CMIP5 models
Downscaling method: BCSD
Temporal Resolution: Monthly
Spatial Resolution: 800m
Temporal Resolution: 2006-2100
PRISM data for bias correction

Output variables:
Ave Max Temperature
Ave Min temperature
Total Precipitaiton
Ave Humidity
Ave Solar Radiation

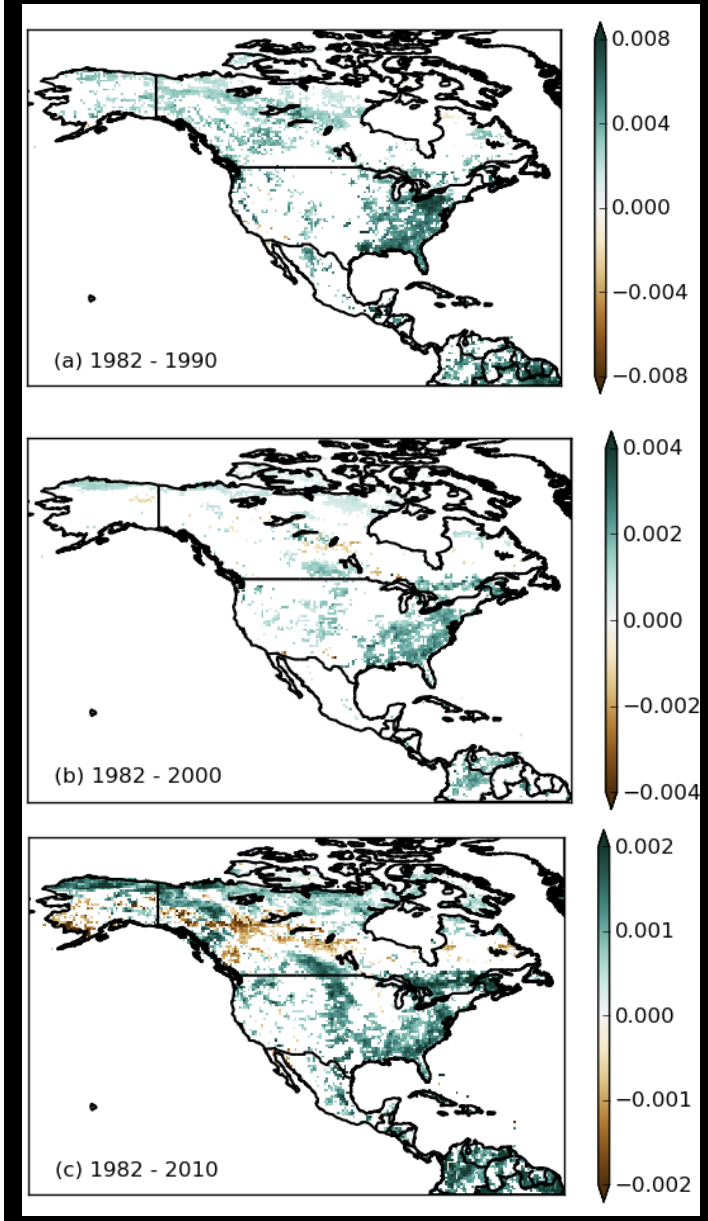
Individual model outputs
Ensemble means
Percentiles

Volume: 22TB

Distribution of the downscaled data

From: GSFC/NCCS
Format: Earth System Grid (ESG)
API from Google Earth Engine

Activity 2: Historical AVHRR data analysis



GIMMS AVHRR NDVI, 1981 – 2011

Special issue of open journal "Remote Sensing"

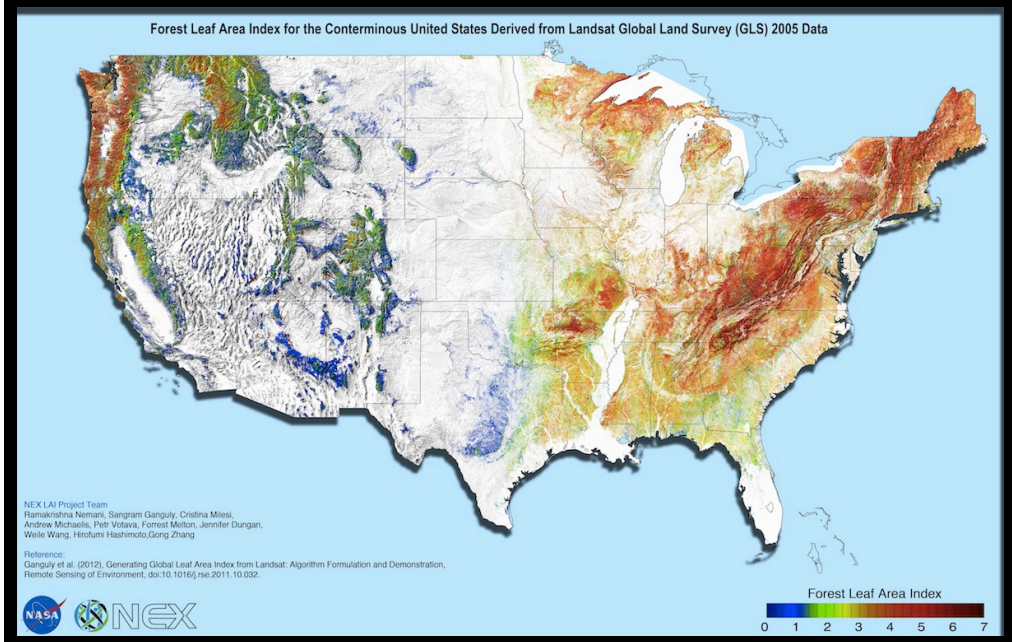
35 manuscripts in preparation

All codes, intermediate results to be available on NEX

All workflows used in generating the manuscripts will be available on NEX

Focus on phenology and productivity

Activity 2: Historical Landsat data analysis



Map of Leaf Area Index (LAI) generated using Landsat Thematic Mapper data and a modified MODIS LAI/FPAR algorithm

Landsat Thematic Mapper 1984-2012

Monthly composites of surface reflectances

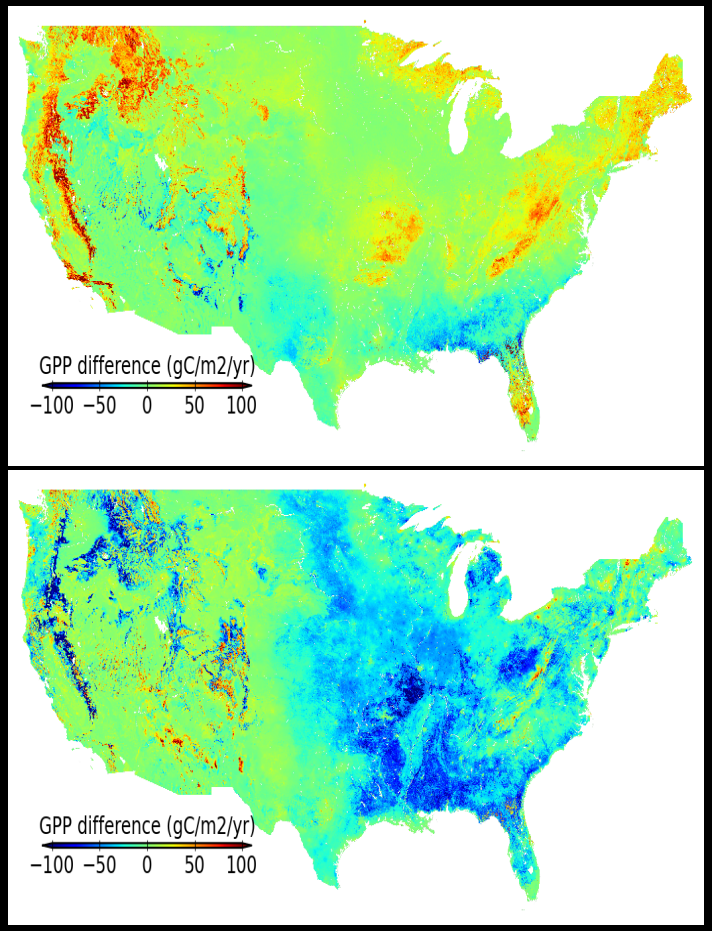
Biophysical products such as LAI

Focus on:

- Land cover changes
- Migration of ecosystems
- High altitude ecosystems
- Forest mortality

Activity 3: Climate impact modeling

BIOME-BGC Simulations of Gross Primary Production (GPP)
Differences in GPP between 2000's and 2080s



Early growing season
Feb - May

Late growing season
Jul - Oct

Extending the MSTMIP (ongoing VEMAP style experiment) modeling into the future

NEX Resources available to the community

Data sets:

- 35 CMIP5 model outputs
- 30 yr AVHRR (1981-2011)
- 1972-2012 Landsat (over 1.8 million scenes)
- 800m Downscaled CMIP5 data

Models:

- BGC
- LPJ
- VIC
- TOPS
- RegCM

Tools

- CDAT visualization
- VisTrails workflow management

Community Engagement

Academic Institutions

1. Walter Jetz, Yale University
2. Andy Hansen, Montana State U
3. Y.Q. Yang, U of RI
4. R. Waring, Oregon State
5. Steve Running, U of Montana
6. Scott Geotz, WHRC
7. Debbie Huntzinger, U of Northern Arizona
8. Ranga Myneni, Boston U
9. Sam Goward, U of Maryland
10. Ed Maurer, Santa Clara U
11. Randy Wynne, Virginia Tech
12. Balaji Rajagopalan, U of Colorado
13. Jonathan Overpeck, U of Arizona
14. Dan Cayan, Scripps Inst. Of Oceanography
15. Larry Band, U of North Carolina
16. David Roy, South Dakota State U.
17. Ralph Keeling, Scripps Inst. Of Oceanography

Federal Agencies/labs

1. USGS, Jeff Morisette, Prasad T.
2. NOAA, Marty Hoerling, Eric Danner, Mark Eakin
3. USBR, Levi Brekke
4. USFS, Warren Cohen, Jessica Haas
5. EPA,Don Hodge
6. USFWS,Tom Oliff
7. CASI team, Cristina Milesi
8. NPS, John Gross
9. LLNL, Phil Duffy

Non-Profit

1. Climate Central, Bridget Thrasher
2. Cal Academy of Sciences, Healy Hamilton
3. John Musinsky, Conservation Int.

PUBLICATIONS

Gopalakrishnan, R. G. Bala. M. Jayaraman, L. Cao, R. Nemani and H. Ravindranath. 2012. Sensitivity of terrestrial water and energy budgets to CO2-physiological forcing: an investigation using an offline land model. Environmental Research Letters, 6: DOI: 10.1088/1748-9326/6/4/044013.

Bala, G., K. Caldiera, R. Nemani, G. Ban-Weiss and H. Shin. 2012. Albedo enhancement of marine clouds to counteract global warming: impacts on the hydrological cycle. Climate Dynamics, 37, 915-931.

Hashimoto, H, W. Wang, C. Milesi, M. A. White, S. Ganguly and et al., 2012. Exploring simple algorithms for estimating Gross Primary Production in Forested Areas from Satellite Data. *Remote Sensing*, 4, 303-326; doi:10.3390/rs4010303.

Ganguly, S., R. Nemani, G. Zhang, H. Hashimoto, C. Milesi and et al. 2012. Generating global Leaf Area Index from Landsat: Algorithm formulation and demonstration. *Remote Sensing of Environment*, doi:10.1016/j.rse.2011.10.032.

Weng, E., Y. Luo, W. Wang, H. Wang, D.J. Hayes, and et al., 2012. Ecosystem carbon storage capacity as affected by disturbance regimes: a general theoretical model. *Journal of Geophysical Research*, 117, doi:10.1029/2012JG002040.

Samanta et al., 2012. Seasonal changes in leaf area of Amazon forests from leaf flushing and abscission, J. Geophys. Res. VOL. 117, G01015, doi: 10.1029/2011JG001818

L. Xu, R. B. Myneni, F. S. Chapin III, T. V. Callaghan, J. E. Pinzon, C. J. Tucker, H. Tømmervik, E. S. Euskirchen, S. Piao, P. Ciais, S. Ganguly, R. R. Nemani, J. C. Stroeve, B. C. Forbes. 2012. Diminishing Seasonality in Northern Vegetation Photosynthetic Capacity From Amplified Surface Warming During 1981 to 2010. Nature Climate Change (in revision).

Wang, W., P. Ciais, R. Nemani, J.G. Canadell, S. Piao, and et al., 2012. Variations in atmospheric CO2 growth rates controlled by tropical temperature. *PNAS* (*in revision*).

Bala, G, N. Devaraju, R. Chaturvedi, K. Caldeira, and R. Nemani. 2012. Nitrogen deposition: How important is it for global terrestrial carbon uptake?, PNAS (in review)

Zhang, G., S. Ganguly, R. Nemani, M. White, W. Wang, and et al., 2012. A simple parametric estimation of live forest aboveground biomass in California using satellite derived metrics of canopy height and leaf area index. *Biogeosciences* (*in review*)

FY13 PLANS

Workflow management

Visualization

Data dissemination/support

Work with impact modeling teams